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REMARKS

This amendment addresses the issues raised in the final Action dated November 26, 2002. The Office Action has rejected Claims 10-20 under 35 U.S.C. §103(a) as defining subject matter which is allegedly rendered obvious by the teachings in U.S. Patent No. 6,239,033 to Kawai ("Kawai") in view of U.S. Patent No. 5,834,325 to Motoki, et al. ("Motoki, et al.").

It is respectfully submitted that the present application is in condition for allowance in view of the following Remarks. Favorable consideration is respectfully requested.

Claim 15 has been amended and claims 21 and 22 have been added. Support for these amendments is found in the instant application. No new matter is added.

The present invention is directed, inter alia to a method of manufacturing a nitrogen-based semiconductor layer grown on a hetero-substrate with a bottom layer of the nitrogen-based semiconductor layer attached to the hetero substrate, comprising the steps of:

forming, on an upper surface of the nitrogen-based semiconductor layer, a protection layer composed of a predetermined material so that the protection layer covers completely the upper surface of the nitrogen-based semiconductor layer; and

etching out the hetero-substrate by the use of an etchant for the hetero-substrate with the upper surface of the nitrogen based semiconductor layer completely covered with the protection layer while the hetero-substrate is being etched.

Kawai does not teach, disclose or suggest the present invention. More specifically, Kawai discloses the process of making a FET by growing GaN semiconductor layers on the surface of a sapphire substrate wherein the bottom surface of the sapphire substrate is processed by lapping using an abrasive liquid containing a diamond granular abrasive material and reducing the thickness of the sapphire substrate to 100 μm or less. Thereafter, the bottom

surface of the sapphire substrate is processed by etching using an etchant of phosphoric acid or phosphoric acid/sulfuric acid mixed liquid to remove a strained layer by lapping. Then, after making a via hole by etching the bottom surface of the sapphire substrate, the GaN semiconductor layer at the bottom of the via hole is removed by RIE to expose an Au an electrically connected to the source of the GaN FET. Thereafter, a thick Au film electrically connected to the Au pad is made through via hole.

Kawai does not teach, disclose or suggest the use of a protection layer on the surface of a nitrogen-based semiconductor layer. Furthermore, it does not teach, disclose or suggest that a protection layer completely covers the upper surface of the nitrogen-based semiconductor, while the hetero-substrate is being etched, as claimed.

The Office Action refers to Figure 12 and column 12, line 45-67 and column 13 to column 14 of Kawai and alleges that Kawai teaches forming an InGaN layer forming metal layer "60" as a protection layer. Applicants disagree that Kawai teaches or discloses a protection layer therein.

Attention is directed to Figures 7-11 of Kawai and the text accompanying same. As described therein, the GaN semiconductor layer 22 is grown on a surface of a sapphire substrate 21 and is partially covered with a Au pad 24 and thereafter covered with an inter-layer insulating film 25. The Au pad 24 and the inter-layer insulating film 25 are finally left on the GaN semiconductor layer 22 together with the sapphire substrate 21, as shown in Figure 11.

From this fact, it is readily understood that Kawai never teaches etching both a downward side and an upward side of the GaN semiconductor layer 22 to leave the GaN semiconductor layer 22 alone. In other words, Kawai never teaches leaving the nitrogen-based semi-conductor layer alone. Therefore, the Au pad 24 partially covers the GaN semiconductor

layer and never covers the entire surface of the GaN semiconductor layer 22. On the other hand, the protection layer of the present method covers completely the upper surface of the nitrogen based semiconductor layer. The prior art reference also shows that the Au pad 24 never serves as a protection layer, because the GaN semiconductor layer is partially etched by an etchant through a portion uncovered with the Au pad 24. Thus, in Kawai, the upper service of the nitrogen based semiconductor is not completely covered with the protection layer while the hetero-substrate is being etched.

Moreover, unlike the present invention, Kawai does not teach, disclose or suggest leaving the nitrogen-based semi-conductor layer alone during the etching process. Even the Office Action agrees, as the Office Action admits that Kawai does not teach removing the entire substrate.

The secondary reference, Motoki, et al., does not overcome the inadequacies of the primary reference.

Motoki, et al. are directed to a light emitting device obtained by forming a gallium nitride compound layer on a GaAs substrate and thereafter at least partially removing the GaAs substrate. In Motoki, et al., a gallium nitride compound layer is formed on a GaAs substrate, and thereafter the GaAs substrate is at least partially removed for forming the light emitting device. Due to the removal of the GaAs substrate, the quantity of light absorption is reduced, relative to the device in which the GaAs is maintained.

In Motoki, et al., a GaAs substrate 8 is partially removed to expose a surface of a GaN buffer layer 1 on the removed portion. In addition, the GaAs substrate 8 may be entirely removed by etching, thereby forming an epitaxial wafer consisting of only a nitride mixed crystal

layer 9 (column 7, lines 31 to 33). This nitride mixed crystal layer 9 is composed of a plurality of GaN epitaxial layers 2 to 6 and is not covered with any protection film at all.

Thus, Motoki, et al. never teach etching from both downward and upward sides of the GaAs substrate 8.

In addition, Motoki, et al. do not teach, disclose or suggest forming a protection layer which covers the entire surface of the nitrogen based semiconductor layer and then etching the hetero-substrate with the upper surface of the nitrogen based semiconductor layer being completely covered, as claimed. Further, it does not teach or suggest leaving the nitrogen-based semiconductor alone during the etching process, as required by the present invention.

Moreover, inasmuch as neither reference teaches placing a protective layer on a nitrogen based semiconductor and then etching out from the hetero-substrate while the upper surface of the semiconductor is completely covered, the prior art references, in combination, do not suggest putting a protection layer covering the entire surface of the nitrogen-based semiconductor layer and etching out of the hetero-substrate while the upper surface of the nitrogen based semiconductor is completely covered. Thus, the prior art references do not teach, disclose or suggest the present invention. Nor does the combination teach or suggest leaving the nitrogen-based semiconductor layer alone during the etching process, as claimed.


In contrast, in the present invention, there is a step of forming on the surface of the nitrogen-based semiconductor layer a protection film as illustrated in Figures 2A and 5A. Under the circumstances, etching is executed from both downward and upward sides to leave the nitrogen based semi-conductor layer (15, 35) alone. Thus, the prior art reference does not teach, disclose or suggest the present method as claimed.

It appears that the Office Action is focusing on Claim 10 for its rejection of the claims. Claim 10 recites that the nitrogen based semiconductor layer is $\text{In}_x\text{Ga}_{1-x}\text{N}$ or $\text{Al}_x\text{Ga}_{1-x}\text{N}$. However, Claim 10 is not an independent claim but is dependent on Claim 15. Inasmuch as Claim 10 and the other claims in the application are dependent on Claim 15, it incorporates the subject matter therein. Since the subject matter of Claim 15 is not rendered obvious by the prior art, the claims dependent thereon including Claim 10 is not rendered obvious by the prior art.

Therefore, for the reasons presented, the rejection of Claims 10-20 under 35 U.S.C. §103 is overcome; withdrawal thereof is respectfully requested.

Thus, in view of the Remarks hereinabove, it is respectfully submitted that the present case is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,


Mark J. Cohen
Registration No. 32, 211

Scully, Scott, Murphy & Presser
400 Garden City Plaza
Garden City, NY 11530
(516) 742-4343
MJC:ae

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